3.6.6. Mission Utility and Integration

3.6.6.1. Purpose

The purpose of this test is to qualitatively assess the integration of the GPS and the INS with the other aircraft navigation systems, the utility of the GPS and INS with the other aircraft avionics systems and sensors and the integration of the GPS and INS displays and controls as an aid for navigation and locating targets in a mission relatable environment.

3.6.6.2. General

In most cases, the GPS and INS are not stand-alone systems. Many modern avionics systems require navigation inputs. Radar and Forward Looking Infrared Radar (FLIR) displays and antennas are often geographically stabilized using INS and/or GPS inputs. The INS can use sensor and other navigation system inputs for position updates. Navigation information is often displayed on radar and FLIR displays, tactical displays and HUDs. A typical system will use radar input to the navigation system which provides initial steering to the target (the navigation system also is stabilizing the radar scan center to maintain detection of the target). The navigation input is then used to steer the FLIR onto the target for a FLIR handoff. The navigation cues are provided on the HUD, often including a navigation system stabilized target designator box, to aid in visually finding the target. If detection is lost, such as during the terminal phase of a DBS radar attack, the navigation system provides final attack cues. Finally, during the weapons release, the navigation system provides inputs to the weapons computer to calculate the proper release point, again providing cues to the pilot.

In most cases, the navigation system requires the widest integration within the complete aircraft of any system and as such is the most challenging to test for integration. Since the output of the INS (latitude and longitude) and of the GPS (latitude, longitude and time) is rarely used directly by the pilot, the issues of integration and accuracy nearly completely define the utility of the INS.

The utility and integration of the navigation system can only be evaluated during mission relatable tasks. For an attack aircraft, the evaluation must be performed during mission relatable ingresses to the target area, detection of the target, handoff between the sensors as would be expected in a tactically significant attack, (for example a handoff from a long range radar detection to a FLIR attack) selection of a weapon and attack mode, and finally, a safe egress from the target area. For a fighter, the evaluation requires navigating to and from a Combat Air Patrol (CAP) station, steering cues to a radar designated target, handoff to an air-to-air FLIR or other electro-optic sensor for VID as well as navigation inputs to digital data links and tactical displays. The critical requirement is to select a scenario that reflects the most likely use of the aircraft and to use this scenario during the evaluation. For the purpose of this sample test procedure, the test aircraft will be an attack aircraft with a weapons computer, HUD, radar and FLIR, as well as the TACAN and OMEGA systems used to demonstrate the previous tests.

3.6.6.3. Instrumentation

Data cards are required for this test. A voice recorder is highly recommended.

3.6.6.4. Data Required

Record qualitative comments concerning the integration of the GPS/INS system with the aircraft weapons computer, FLIR, HUD, radar and TACAN. Include comments concerning the INS and GPS inputs to these systems as well as the radar and TACAN inputs to the INS for INS updates during tests where the GPS is not used. Evaluate the effects of GPS and INS accuracy upon other systems, for instance the drift rate of radar and FLIR geographically stabilized cursors, once a target is selected, and the resulting workload as the cursors are repeatedly updated. Evaluate the effects of navigation functions, such as INS update procedures, upon operator workload during a mission relatable environment. Assess the utility of the GPS and INS-derived information displayed upon the radar, FLIR, HUD, as well as GPS and INS unique displays including the effects of GPS and INS accuracy, while performing radar to FLIR or HUD handoffs and mission-relatable ingresses, attacks and egresses.

3.6.6.5. Procedure

Select a mission-relatable target in the test area that allows for a 35 to 40 nm ingress to the target location. Select several waypoints inbound to the target. While navigating from the home airfield to the initial waypoint, qualitatively assess the utility of the GPS/INS accuracy and steering cues for long range, IMC navigation. Choose an altitude and airspeed that conserves fuel. Descend to a low ingress altitude and set an airspeed near the sea level limit of the test aircraft. Head inbound to the target and select a radar mapping mode with at least a 40 nm scale and a wide scan pattern useful for radar mapping. Follow the navigation system and radar cues inbound to the target, passing over the waypoints along the route. Select DBS radar modes inbound to the target; and when inside of 10 nm perform a handoff of the target from the radar to the FLIR. Continue inbound to the target, performing a mission-relatable, unguided, ordnance attack on the target. Following the attack, turn outbound from the target and navigate to the initial point on the reverse route using the radar and navigation system cues. Repeat with different weapons deliveries as time allows. Use a voice recorder or write down comments after each run. Care should be taken not to become distracted with recording data to allow the best overall qualitative evaluation. Repeat the test with the INS turned off and then using the INS alone. Finally, repeat the GPS test without the P code installed.

3.6.6.6. Data Analysis and Presentation

Relate the qualitative deficiencies noted to their effects upon the performance of normal IFR navigation, ingresses and attacks. Note any limitations upon tactics imposed by the system accuracy, utility or integration. For instance, the navigation cues used to find the waypoints may require so much operator attention and interpretation that they destroy the scan of the radar display while searching for the target. As another example, the navigation drift may be so high that the stored position of the target may drift radically between the last radar or FLIR update and the weapons release, causing a miss of the target. It is critical that the navigation system utility and integration should not be driving tactics. Use the applicable results from the previous tests to support the qualitative results. Relate the same factors for the INS and GPS-alone configurations to the requirement to perform the mission following a system failure or after having to launch without a complete INS alignment. Relate the configurations where the P code is not installed to the requirement to perform the mission after the P code is lost or when operating out of a base where the P code is not available.

3.6.6.7. Data Cards

A sample data card is presented as card 54.

CARD NUMBER ___ TIME___ PRIORITY L/M/H

GPS/INS MISSION UTILITY AND INTEGRATION

CONFIGURATION: GPS ON ___ INS ON ___ BOTH ON ___ P CODE YES/NO

[AFTER TAKEOFF, CLIMB TO _____ FEET MSL AND SET ___ KIAS. PERFORM NAVIGATION TO THE INITIAL POINT, ASSESSING THE UTILITY OF NAVIGATION SYSTEM ACCURACY AND DISPLAYS FOR IMC NAVIGATION. DESCEND TO ___ FEET AGL AND ___ KIAS AT THE INITIAL WAYPOINT. SET A 40 NM RADAR SCALE AND __° SCAN ANGLE LIMIT. SEARCH FOR THE TARGET ON THE RADAR WHILE NAVIGATING TO THE WAYPOINTS. AT 10 NM, PERFORM A FLIR HANDOFF. PERFORM A __________ ATTACK. AFTER RELEASE, REVERSE THE INGRESS TRACK. REPEAT USING A __________, __________ AND __________ ATTACK AS FUEL ALLOWS.]

TARGET POSITION __________ __________

INITIAL WAYPOINT 1 POSITION __________ __________

WAYPOINT 2 POSITION __________ __________

WAYPOINT 3 POSITION __________ __________

NOTES:

Card 54: GPS/INS Mission Utility and Integration Data Card